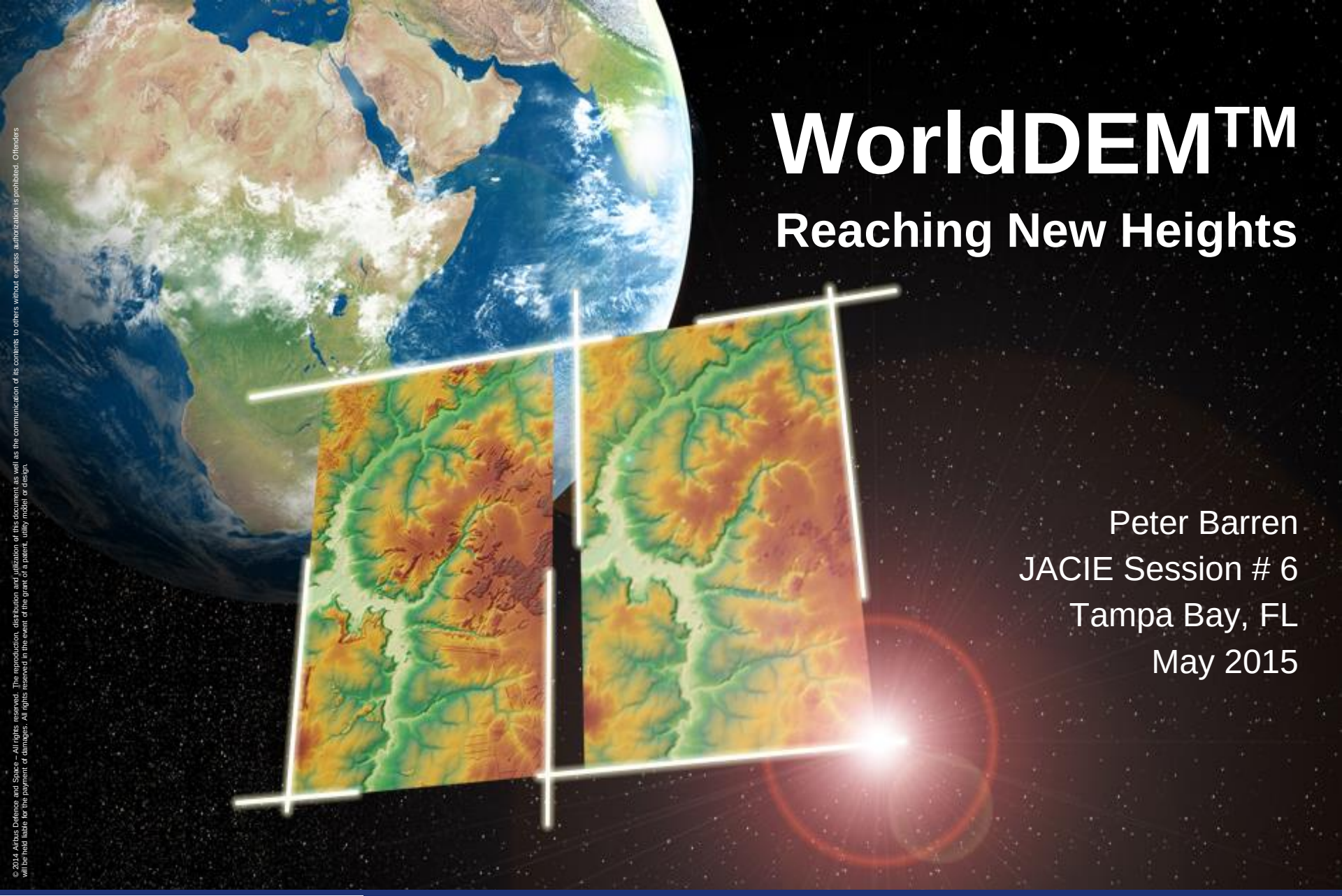


WorldDEM™

Reaching New Heights

Peter Barren

JACIE Session # 6

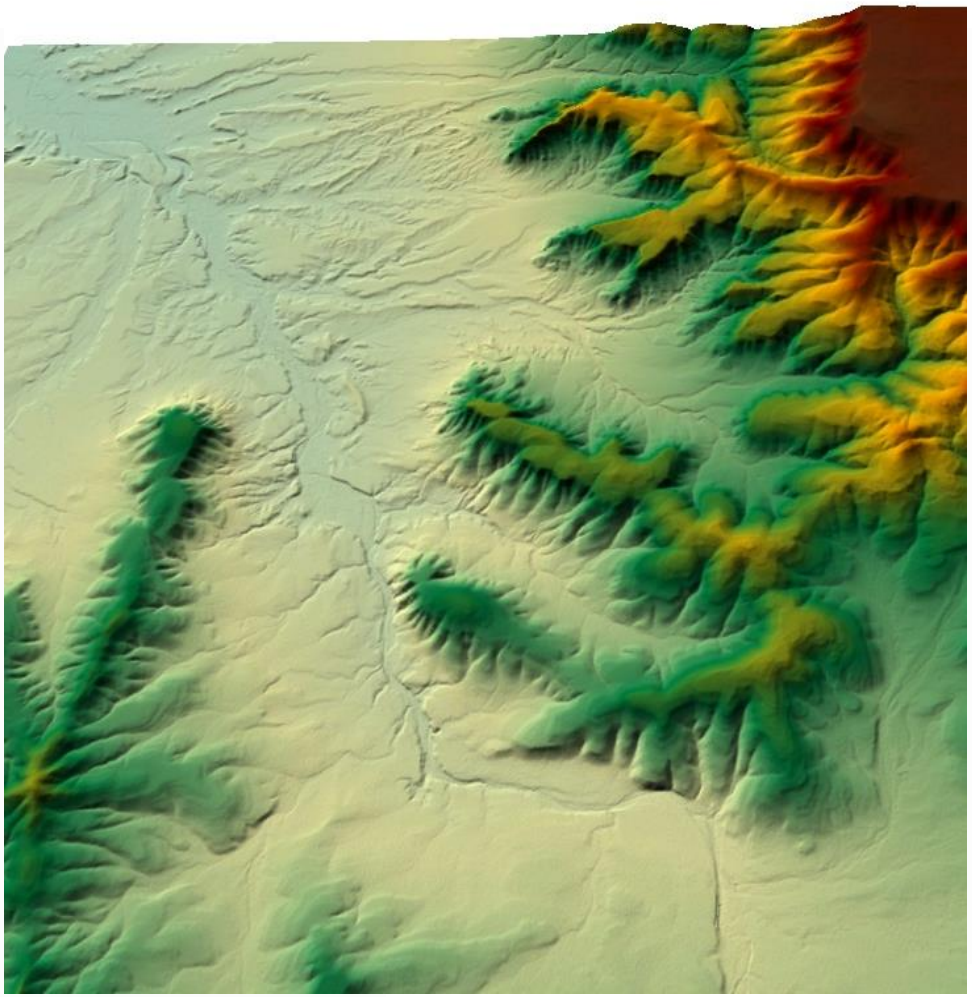
Tampa Bay, FL

May 2015

AIRBUS DEFENSE & SPACE

Content

1. WorldDEM™ Story
   - What's in it for the customer?
2. WorldDEM™ Product Portfolio
   - Products
   - Editing
   - Level of Detail
   - Evaluation
3. Case Studies and Applications
4. Product Availability & Ordering

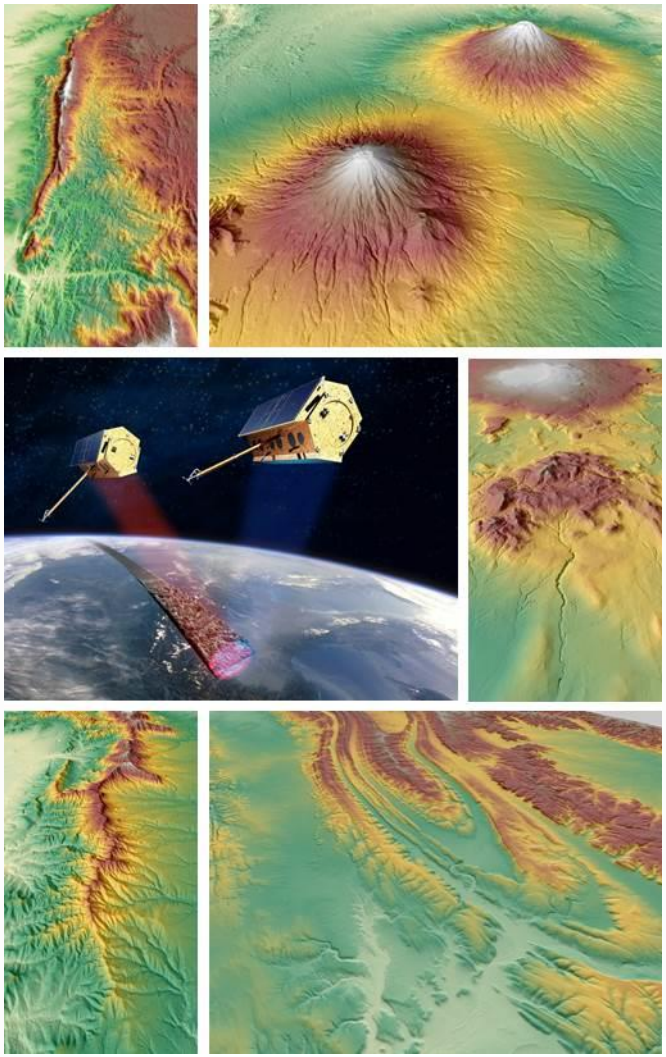


1 WorldDEM™ Story

AIRBUS DEFENSE & SPACE

WorldDEM™ Background

- First worldwide, consistent and seamless DEM product
  - Covering the entire Earth's land mass (pole-to-pole) with unprecedented accuracy and quality
- TanDEM-X Mission
  - Twin Satellites: TerraSAR-X & TanDEM-X flying in a very close and precise formation
  - Mission Goal: homogeneous, high-quality global DEM
  - Data acquisition within 3 years only (one unique source)
- Public-Private Partnership (DLR/Airbus)
  - Commercial exploitation: Airbus Defense and Space
- WorldDEM™ is commercially available since 2014
- WorldDEM™ is part of the GEO Elevation product suite



AIRBUS DEFENSE & SPACE

What is in it for the Customer?

	Product Features	Customer Benefits
Coverage	Worldwide, **pole-to-pole**, covering the Earth's entire land mass (150 Mio km²)	**Standardized** DEM for any spot on Earth at the same **quality**
Quality	**Homogeneous, seamless, consistent** derived from single data source	**Closes gaps and extends to areas missing** so far with **high accuracy**
Accuracy	**High accuracy** at a pixel size of 12m Rel. **vertical** accuracy < 2m/< 4m Abs. **horizontal** accuracy of < 6m	Improves the **performance** of today's globally operating **systems & applications**
Availability	**No acquisition risk** (future) **off-the-shelf** availability	Automatic order process, **easy & instant access** to any spot on Earth in the future
Suits Market Needs	**Surface (DSM)** and **Terrain (DTM) elevation** information is offered	**No matter what elevation information** is needed for projects and applications **WorldDEM™ is ideally suited to assist**

AIRBUS DEFENSE & SPACE

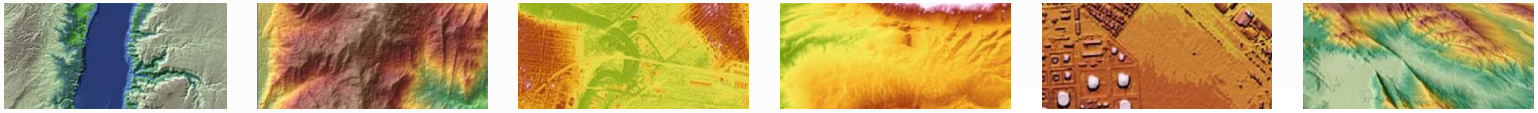
2 WorldDEM™
Product Portfolio

AIRBUS DEFENSE & SPACE

GEO Elevation Heritage and Portfolio

		Elevation30	Elevation10			Elevation8		Elevation4		Elevation1		WorldDEM™
Product		DSM	DSM_{basic}	DSM	DTM	DSM	DTM	DSM	DTM	DSM	DTM	DSM
Sensor		SPOT5 HRS	TerraSAR-X			SPOT6		Pléiades 1A & 1B		Pléiades 1A & 1B		TerraSAR-X & TanDEM-X
Method		Photogrammetry	Radargrammetry			Photogrammetry		Photogrammetry		Photogrammetry		Interferometry
Specification Level		DTED-2	HREGP (HRTE3)			HRE80		HRE40		HRE10		HREGP (HRTE3)
Grid Spacing		1 arc second (~ 30m)	10m			8m		4m		1m		12m
Vertical Accuracy (LE90)	**Abs.**	10m	5m - 10m		10m	≥3m*		≥2m*	2m*	≥1.5m*	1.5m*	4m
	Rel.	8m	<5m		8m	3m		2m	1.5m	1m	1.5m	<2m (slope ≤20%) <4m (slope >20%)
Horizontal Accuracy (CE90)	**Abs.**	6m - 10m	5m - 10m		10m	≥2.5m*		≥1.5m*	≥1.5m*	≥1.5m*	1.5m*	<6m
	Rel.	5m	<5m		5m	2m		1.5m	n.a.	1.5m	n.a	n.a.
Minimum Order		3000 km²	500 km² [& 20km width]			1,000 km² [& 20km width]		100 km² [& 10km width]		100 km² [& 10km width]		500 km² [& 10km width]
Coverage		>75 Mio km² available	On demand			On demand		On demand		On demand		Globally available (pole-to-pole)

*Elevation 8, 4 & 1 accuracy dependent on ground control points (GCPs); valid for slopes ≤20%



AIRBUS DEFENSE & SPACE

WorldDEM™ Product Line

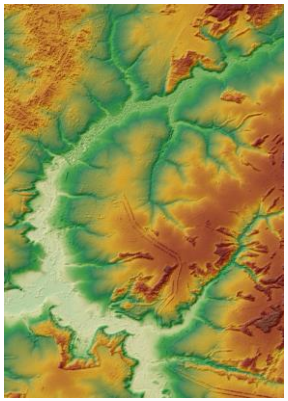
Digital Surface Model representing the surface of Earth including heights of buildings and other man-made objects, trees, forests and other vegetation

WorldDEM$_{core}$ - unedited DSM (incl. spikes, wells, voids)

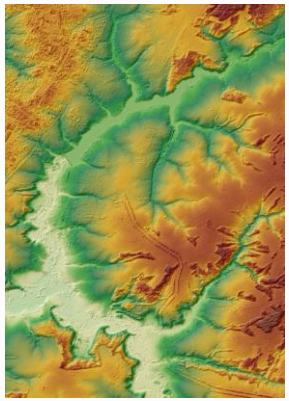
WorldDEM™ - edited DSM incl. editing of terrain features & water bodies

Digital Terrain Model representing the elevation of the bare Earth

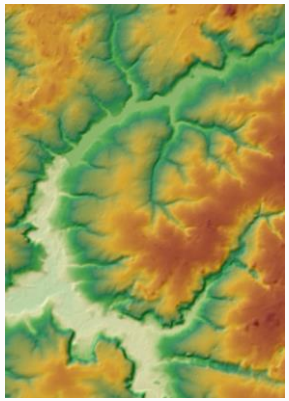
WorldDEM™ DTM - man-made objects and vegetation are removed



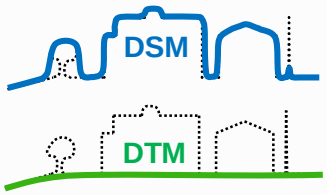
WorldDEM$_{core}$



WorldDEM™



WorldDEM™ DTM

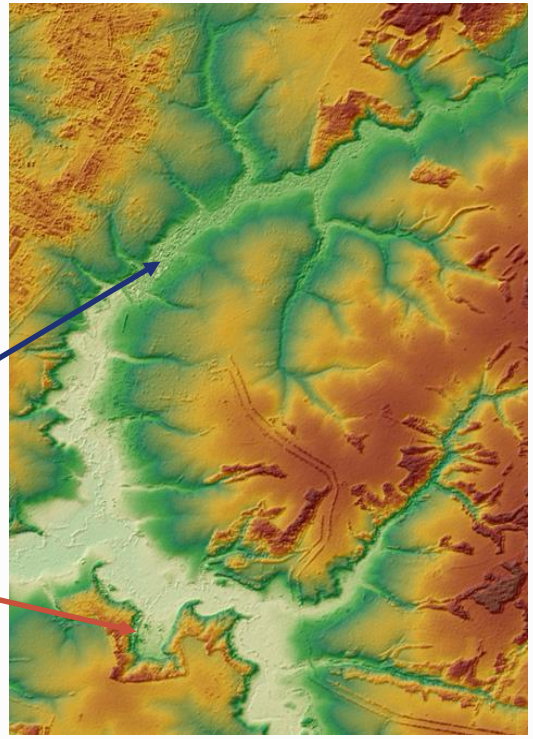


WorldDEM$_{core}$

Unedited Digital Surface Model - incl. heights of all objects (natural & man-made)

No editing is applied at all

- No elimination of radar typical outliers called “spikes” and “wells” which have no relation to the relief height
- Voids and data gaps can occur
- Processing artifacts can appear in the data
- Water bodies stay unedited: no flattening of oceans, lakes and rivers is applied



WorldDEM$_{core}$ delivery includes:

- Metadata (ISO compliant)
- Auxiliary Layers
- Quicklooks

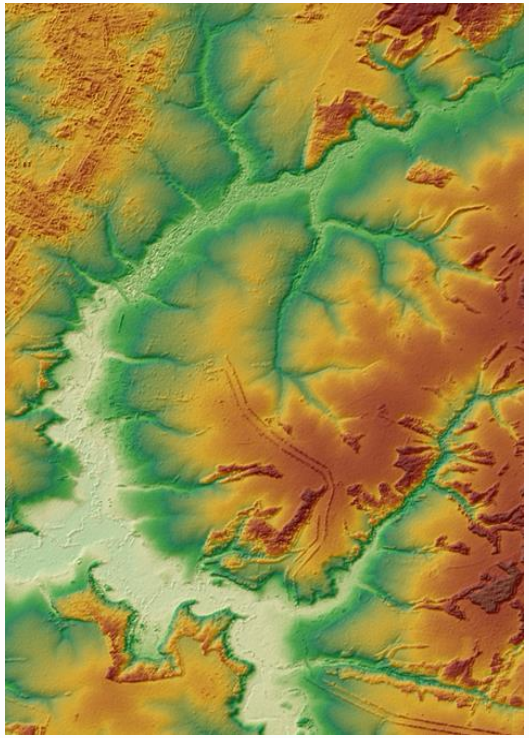
AIRBUS DEFENSE & SPACE

WorldDEM$_{core}$ Package

WorldDEM$_{core}$ is delivered including:

- Metadata: XML-Format, ISO 19115 compliant
- Source Mask (kml)
- Quicklook images
- Auxiliary Layers - which were generated during production process

Auxiliary Layer		Data Format
Amplitude Mosaic (mean value)	AMP	16 bit unsigned integer, GeoTIFF
Amplitude Mosaic (min. value)	AM2	16 bit unsigned integer, GeoTIFF
Consistency Mask	COM	8 bit unsigned integer, GeoTIFF
Coverage Map	COV	8 bit unsigned integer, GeoTIFF
Height Error Map	HEM	32 bit floating point, GeoTIFF
Layover/Shadow Mask	LSM	8 bit unsigned integer, GeoTIFF
Water Indication Mask	WAM	8 bit unsigned integer, GeoTIFF
Reliability Mask	RLM	8 bit unsigned integer, GeoTIFF



WorldDEM™

Edited Digital Surface Model - incl. heights of all objects (natural & man-made)

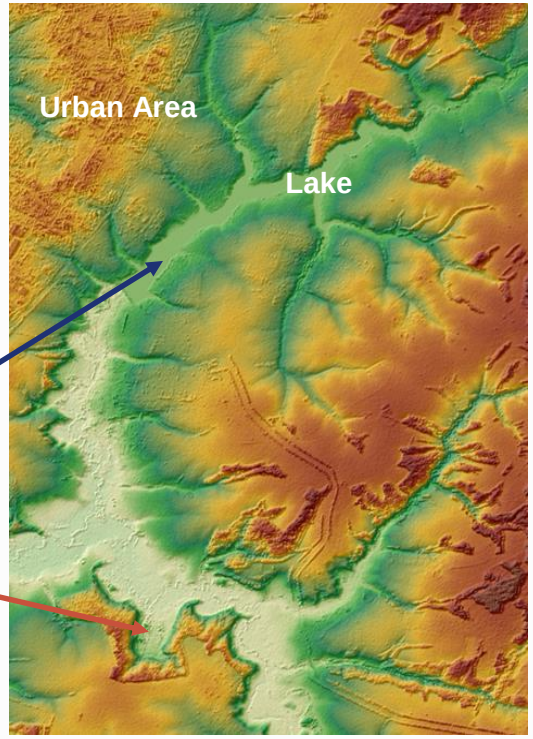
The following editing steps and rules are applied:

Terrain editing

- Removal of radar-typical artefacts (“spikes” and “wells”)
- Interpolation and filling of voids

Water body editing*

- Lakes & reservoirs: set to single elevation
  - Water bodies: width: >50m, length: >500m
- Rivers & canals: flattened with monotonic flow
  - Water bodies: width: >50m, length: >300m
- Ocean elevation is set to 0 m
- Coastal infrastructure features and bridges are removed



** Extraction of water body features derived from radar image*

WorldDEM™ delivery includes:

- Metadata (ISO compliant), Stylesheets
- Quicklooks
- Optional: Quality Layers

WorldDEM™ Package

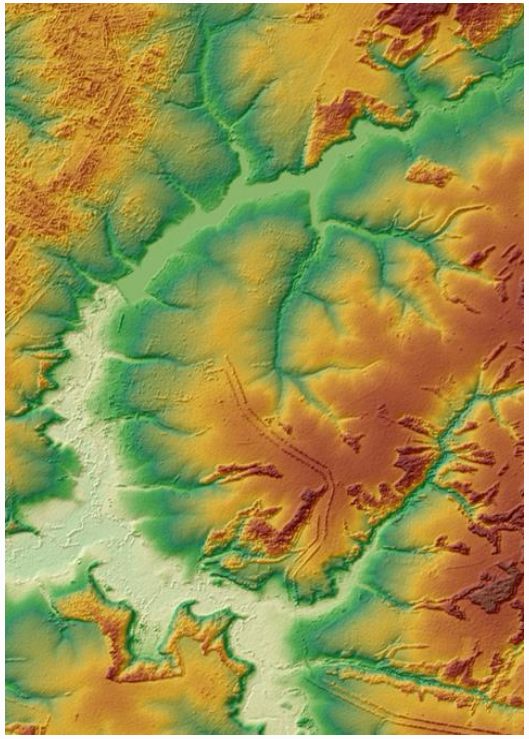
WorldDEM™ is delivered including:

- Metadata: XML-Format, ISO 19115 compliant
- Source Mask (kml)
- Quicklook images

Optional:

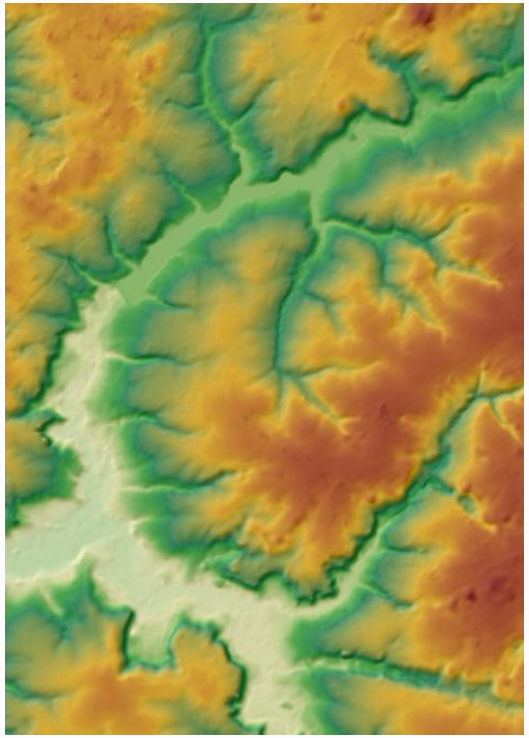
Quality Layers can be ordered with WorldDEM™ product

Quality Layer		Data Format
Amplitude Mosaic (mean value)	AMP	16 bit unsigned integer, GeoTIFF
Filling Mask	FLM	8 bit unsigned integer, GeoTIFF
Editing Mask	EDM	8 bit unsigned integer, GeoTIFF
Water Body Mask	WBM	8 bit unsigned integer, GeoTIFF



WorldDEM™ Specifications

Products		DSM	DTM
Vertical Accuracy	Abs.	<4m	<10m (LE90)
	Rel.**	<2m (slope ≤20%) (LE90) <4m (slope >20%) (LE90)	<5m (LE90)
Horizontal Accuracy	Abs.	<6m (CE90)*	
Grid Spacing		Latitude: 0.4” (~ 12m) Longitude: depending on Latitude (~12m)	
File Format		GeoTIFF	
Data Type		32-bit floating	
Vertical Unit		Meter	
Projection Information		Geographic Coordinates	
Coordinate Reference System		• Horizontal reference datum: WGS84 • Vertical reference datum: EGM2008	
Metadata		XML-Format, ISO 19115 compliant	



* < 10 m TanDEM-X Mission Goal

** 90% linear point-to-point error within an area of 1° x 1°

AIRBUS DEFENSE & SPACE

WorldDEM DTM

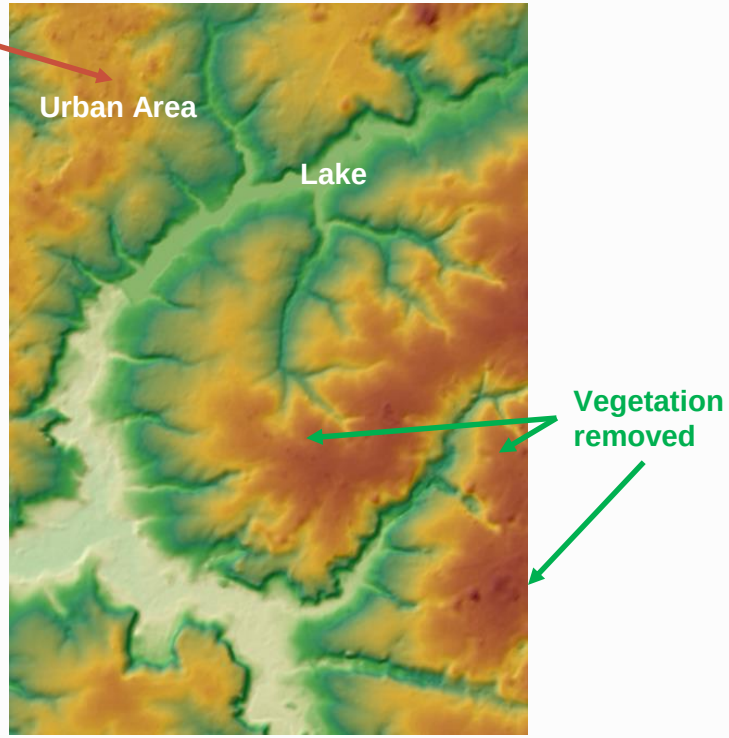
Edited Digital Terrain Model - bare Earth elevation w/o obstruction features above ground

Surface Features are removed:

- **Built-up areas** (e.g. buildings, man-made features)
- **Vegetation** (e.g. forest, trees, cropland)

Terrain Features are preserved:

- **Ridge and depth lines** (e.g. mountain crest, narrow valleys)
- **Break lines** (e.g. edge of deeply incised stream beds, plateau and terrace edges)
- **Hydrological barrier features** with significant influence on the hydrologic characteristic of the DTM (e.g. dams, levees, dikes, floodgates, embankments, roads, railways)



WorldDEM DTM delivery includes:

- Metadata (ISO compliant), Stylesheets
- Quicklooks

Optional: Quality Layers

AIRBUS DEFENSE & SPACE

WorldDEM DTM Package

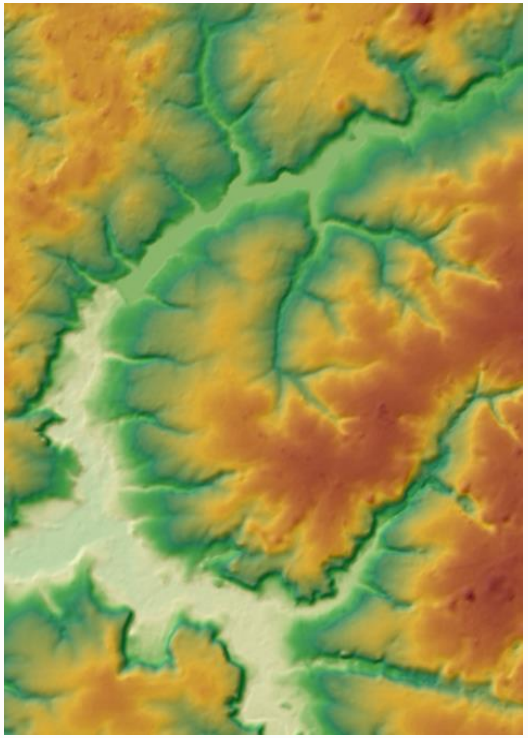
WorldDEM DTM is delivered including:

- Metadata: XML-Format, ISO 19115 compliant
- Source Mask (kml)
- Quicklook images

Optional:

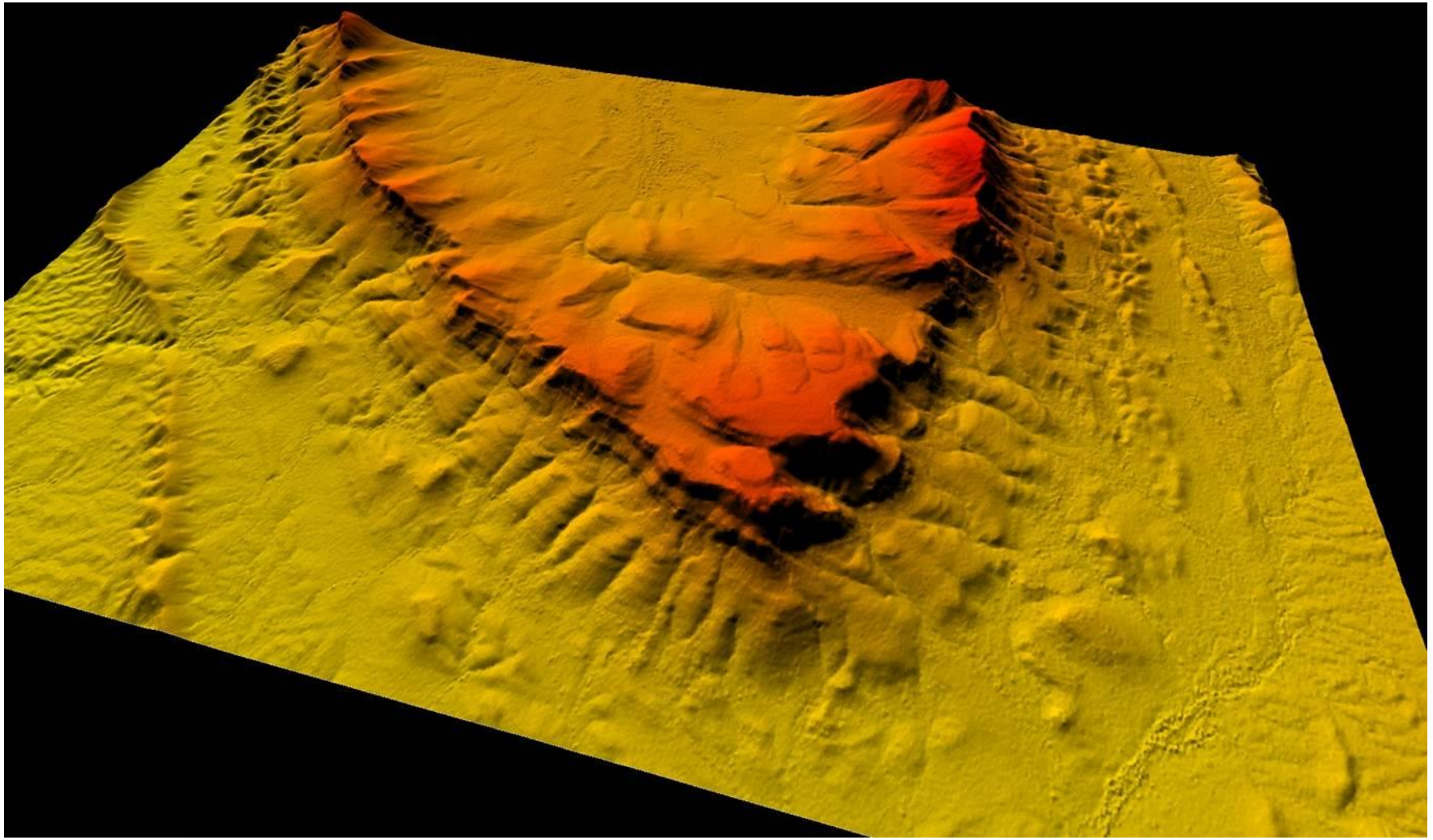
Quality Layers can be ordered with WorldDEM DTM product

Quality Layer		Data Format
Amplitude Mosaic (mean value)	AMP	16 bit unsigned integer, GeoTIFF
Filling Mask	FLM	8 bit unsigned integer, GeoTIFF
Water Body Mask	WBM	8 bit unsigned integer, GeoTIFF



AIRBUS DEFENSE & SPACE

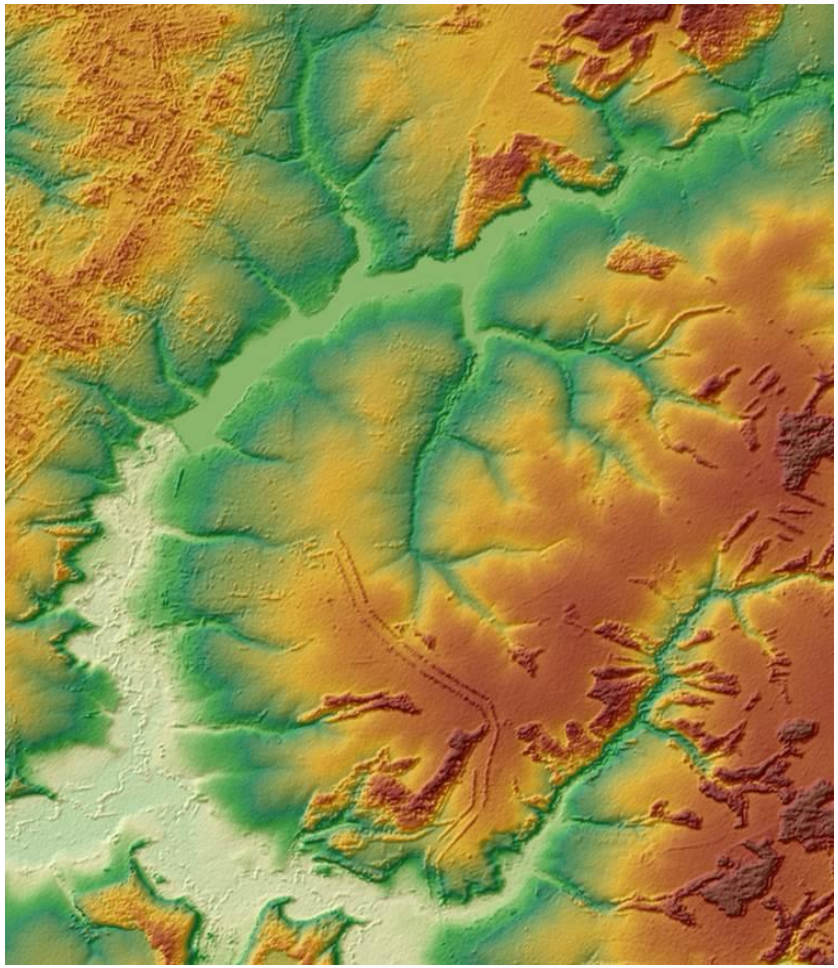
Editing Terrain Artifacts



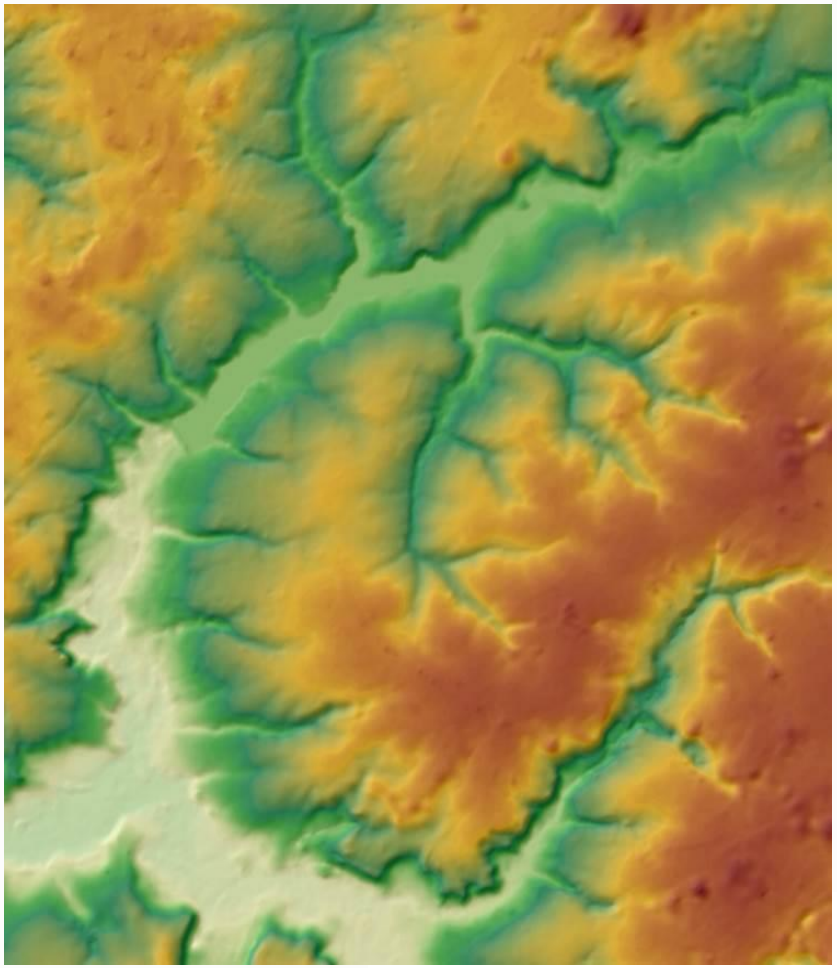
AIRBUS DEFENSE & SPACE

WorldDEM™ - Level of Detail

WorldDEM™



WorldDEM DTM

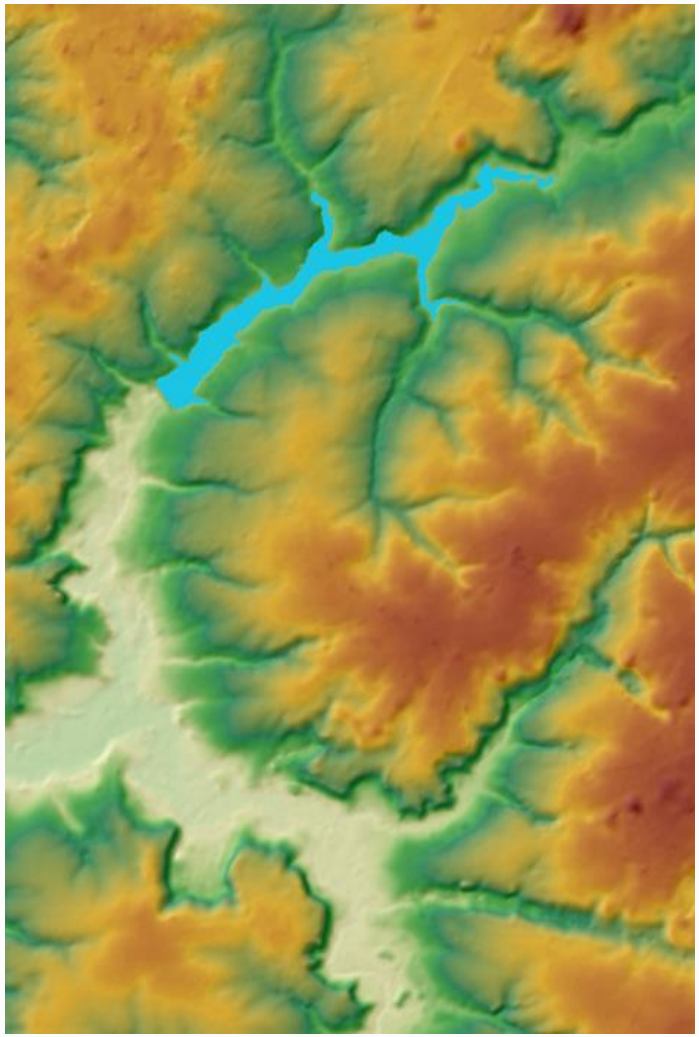


Vladimir, Russia (N56E040)

AIRBUS DEFENSE & SPACE

WorldDEM™ - Level of Detail

Vladimir, Russia
(N56E040)



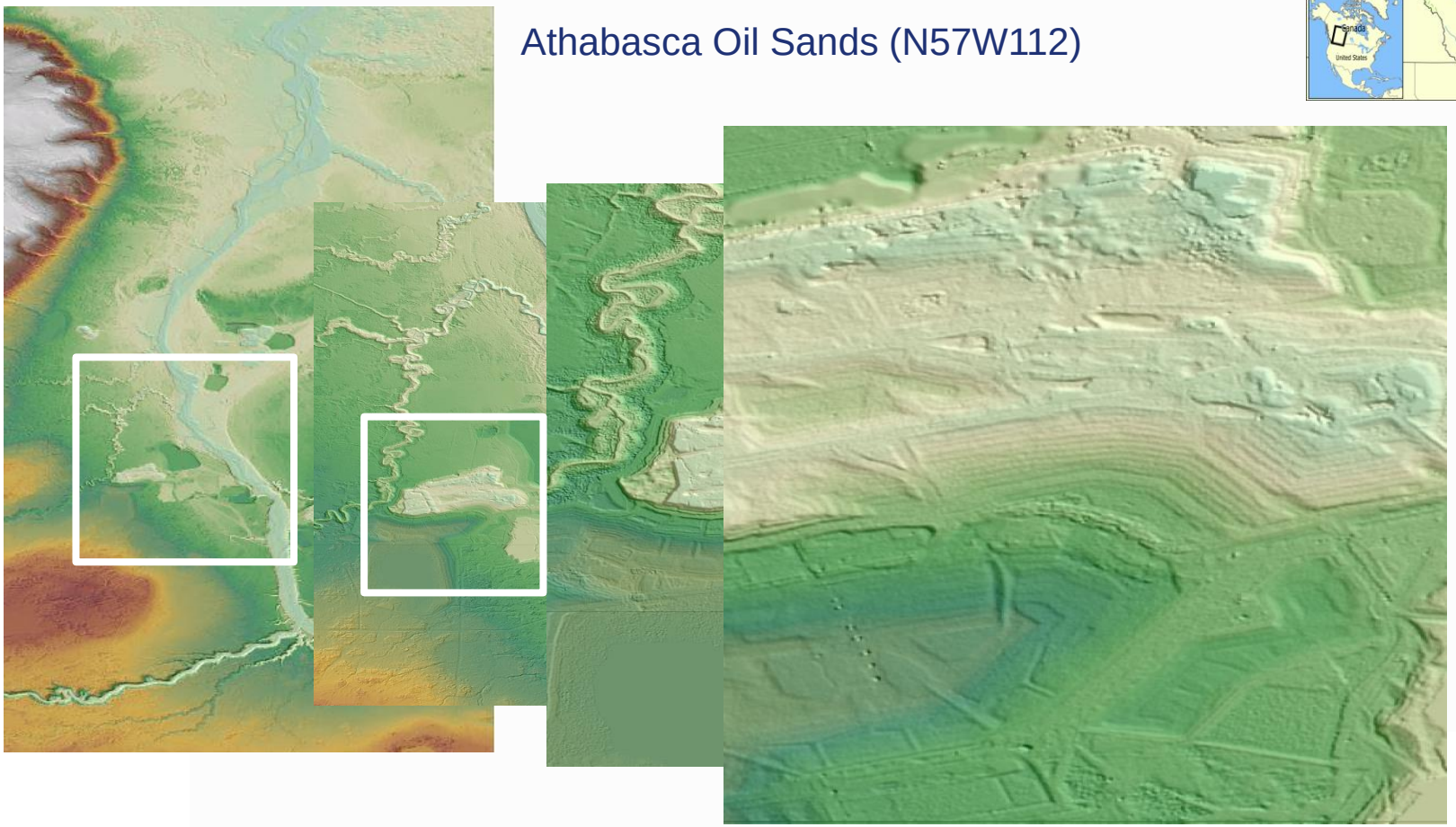
WorldDEM DTM

AIRBUS DEFENSE & SPACE

WorldDEM™ - Level of Detail

Fort McMurray, Canada

Athabasca Oil Sands (N57W112)

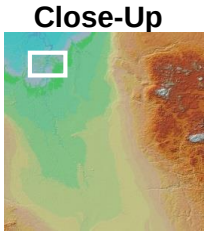


AIRBUS DEFENSE & SPACE

WorldDEM™ - Level of Detail

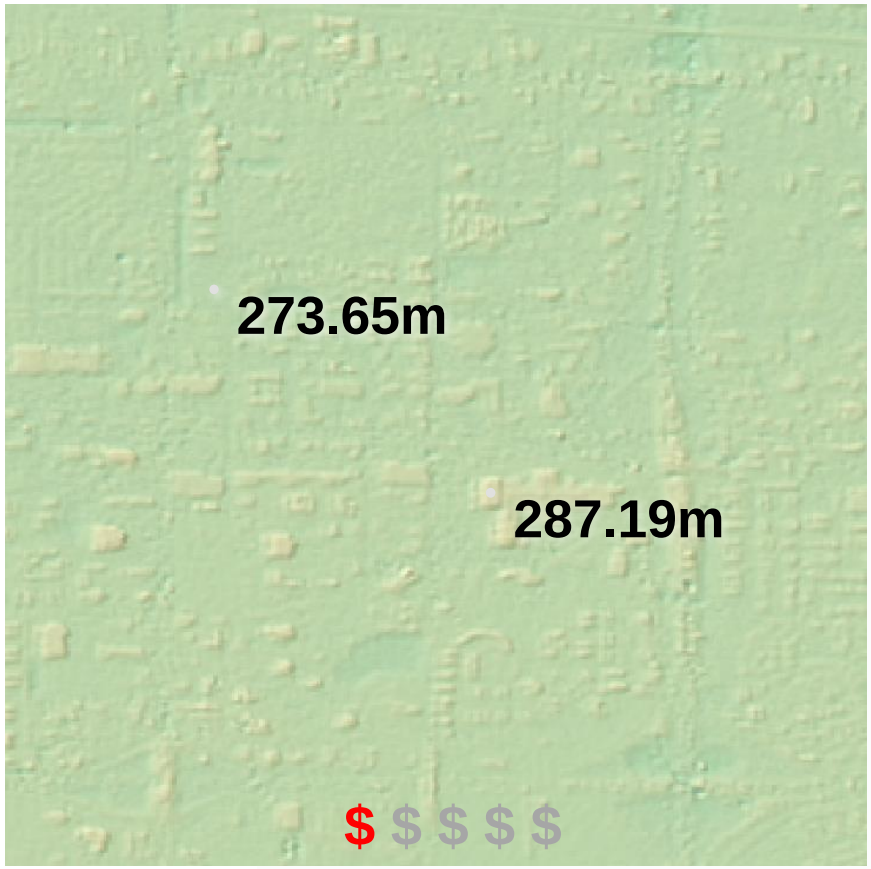
Paraguay, NW of Filadelfia

WorldDEM™ - Level of Detail



Minnesota
W097_N47

WorldDEM™ “urban“

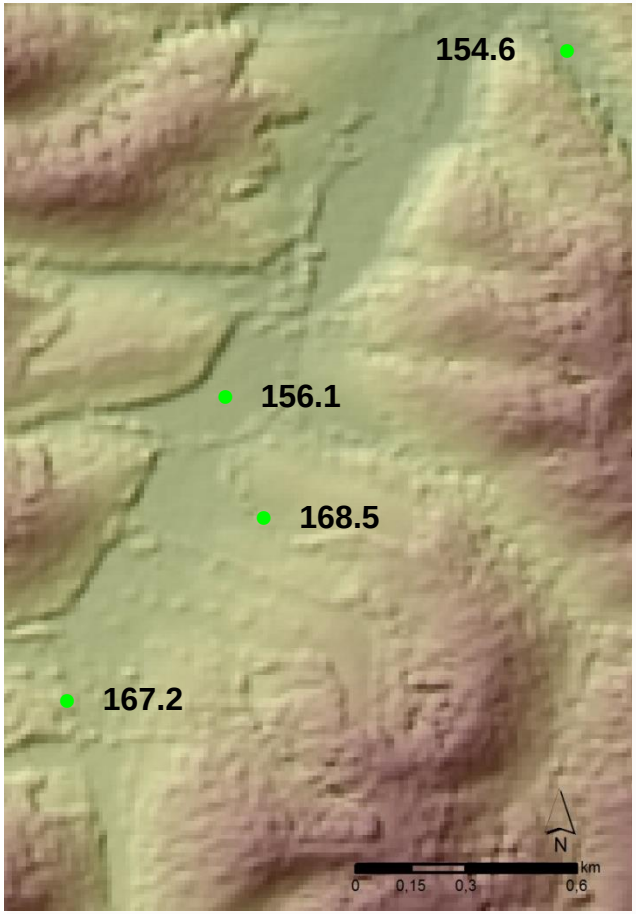


LiDAR DSM “urban“

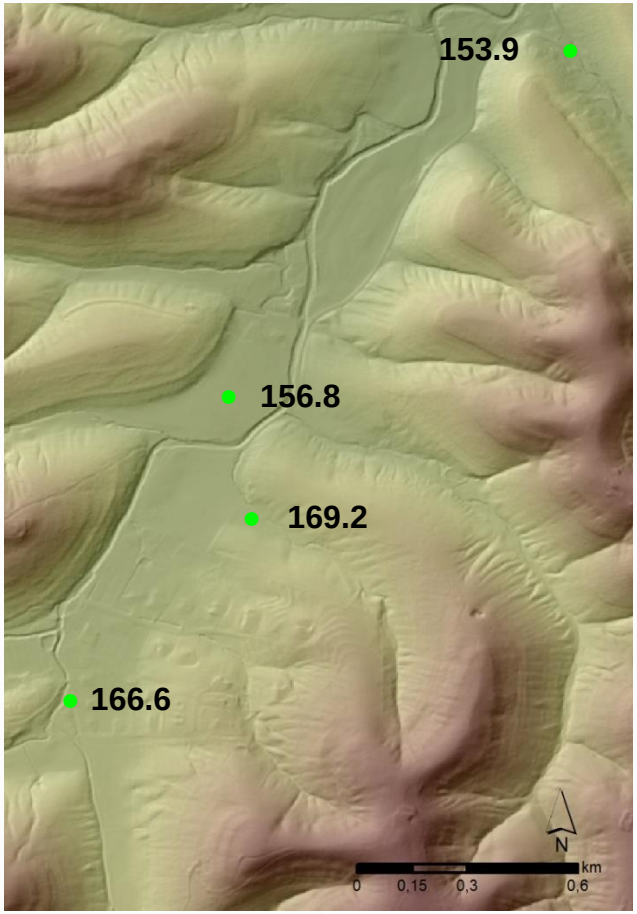
AIRBUS DEFENSE & SPACE

WorldDEM™ - Level of Detail

WorldDEM™ (12m)



National Elevation Dataset (NED) (3m)

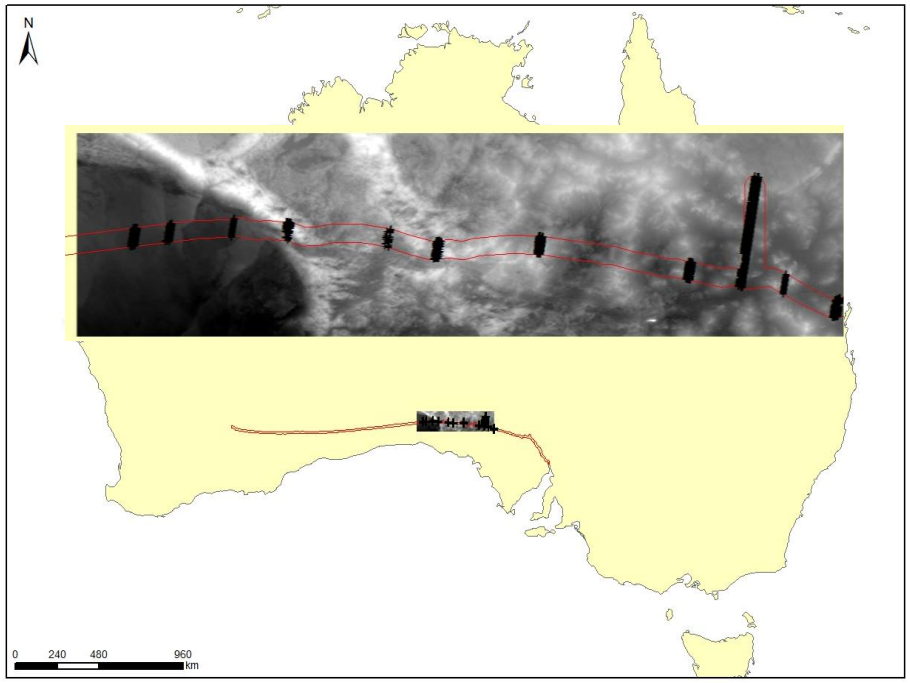


WorldDEM™ Evaluation

Evaluation over an area in Australia using ICESat Points

Area: Corridor of ~390 km length (131°E -135°E)

Number of used ICESat Points: 4516

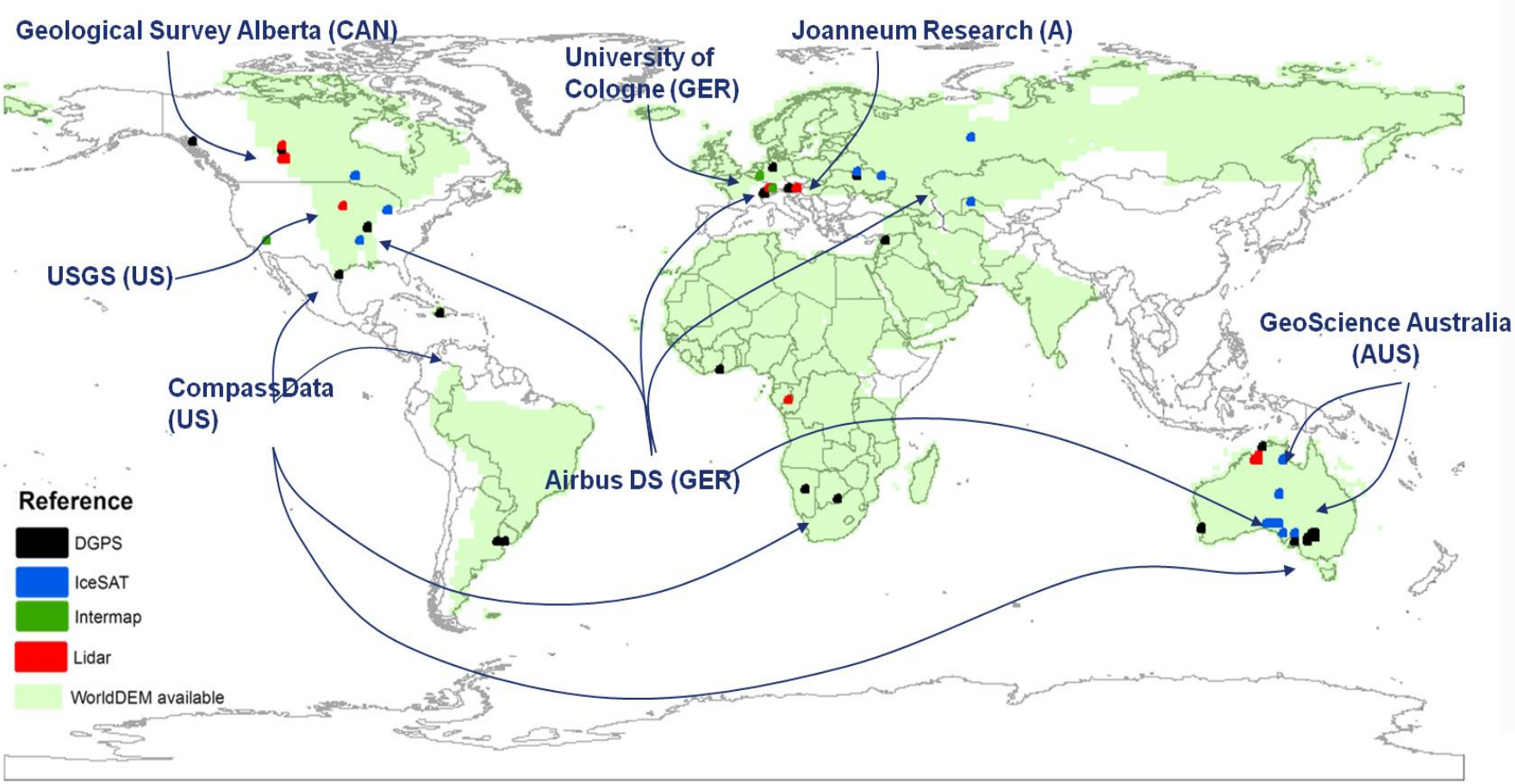


Evaluation Result

	[m]
Mean	-1.3
RMSE	1.4
LE90	**2.3**

Independent WorldDEM™ Evaluation

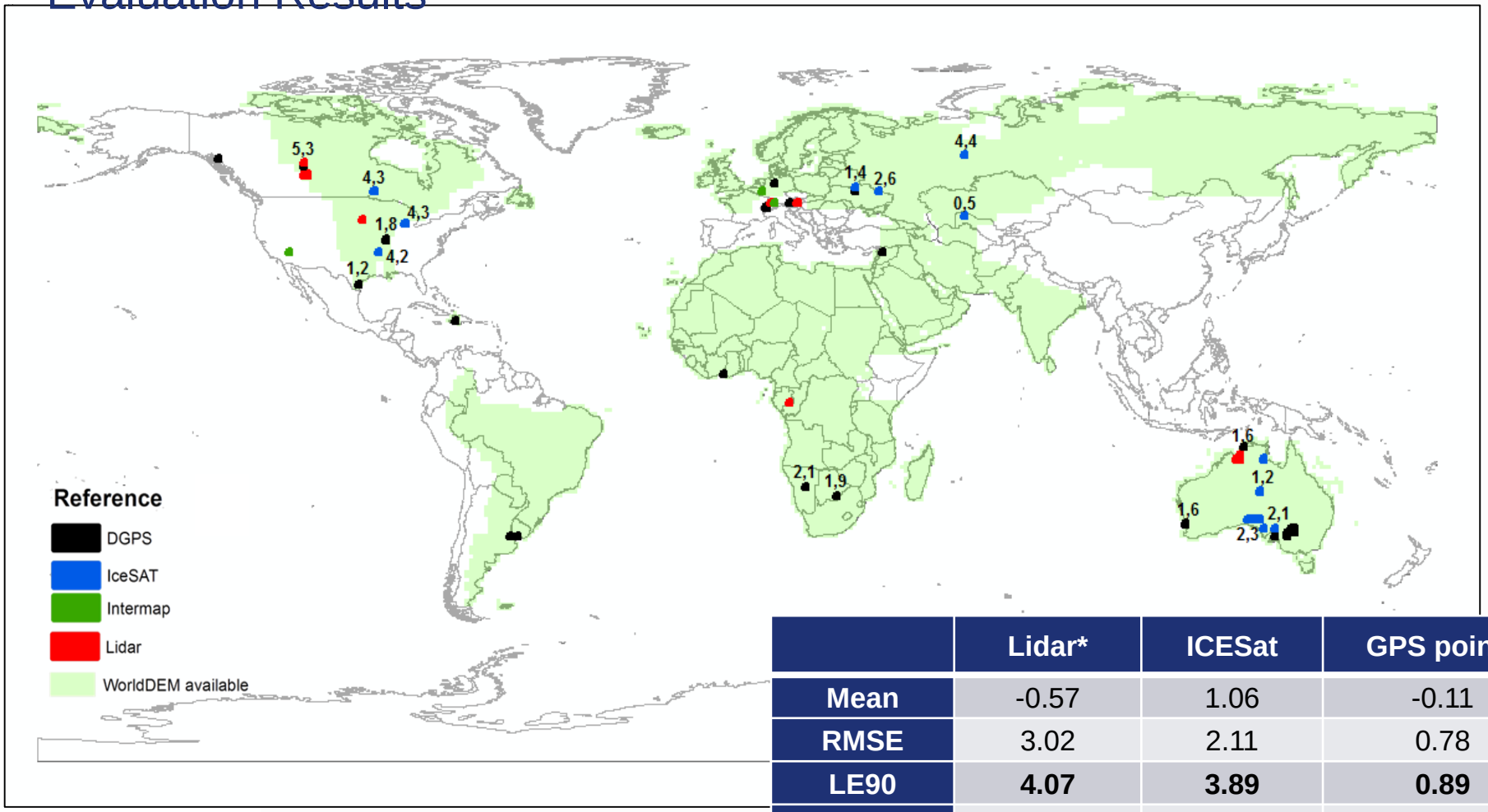
Partners and Data



AIRBUS DEFENSE & SPACE

Independent WorldDEM™ Evaluation

Evaluation Results



	Lidar*	ICESat	GPS points
Mean	-0.57	1.06	-0.11
RMSE	3.02	2.11	0.78
LE90	**4.07**	**3.89**	**0.89**
Geo Cells	4	12	9

* Surface changes between WD & Lidar data takes in two geocells

3 WorldDEM™

Case Studies and Applications

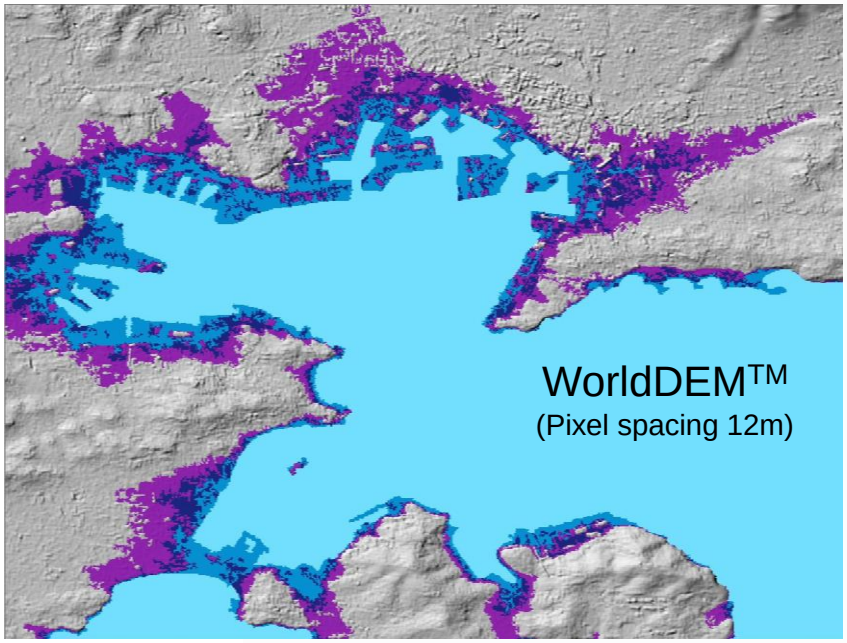
AIRBUS DEFENSE & SPACE

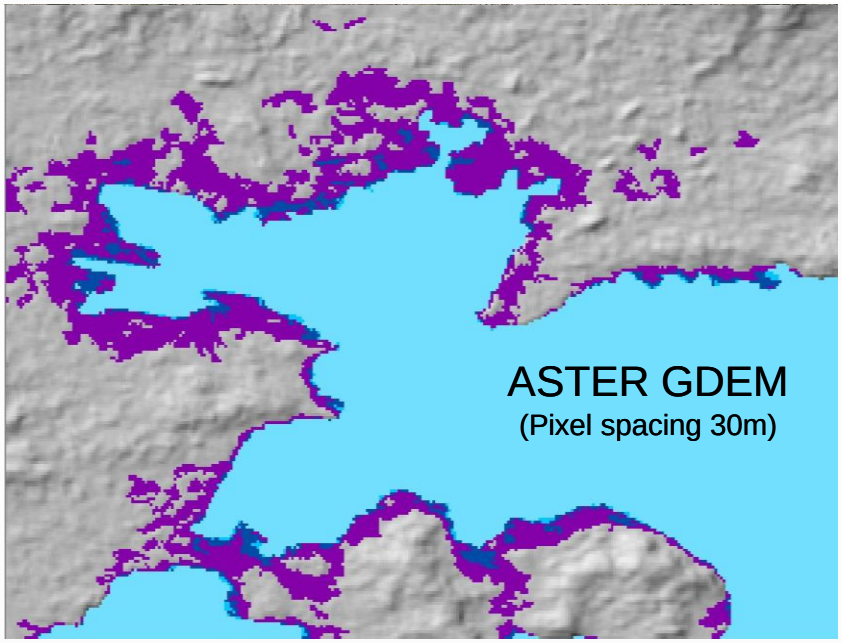
Case Study: Global Sea Level Rise-up

Geomorphological & hydrological impact in human and natural environment

- Loss of soil to the sea
- Increase of saltwater intrusion (e.g. danger of drinking water reservoirs in coastal areas)
- Increase of storm surges, frequency of cyclones and floodings

IncR[EO]
Increasing Resilience through Earth Observation





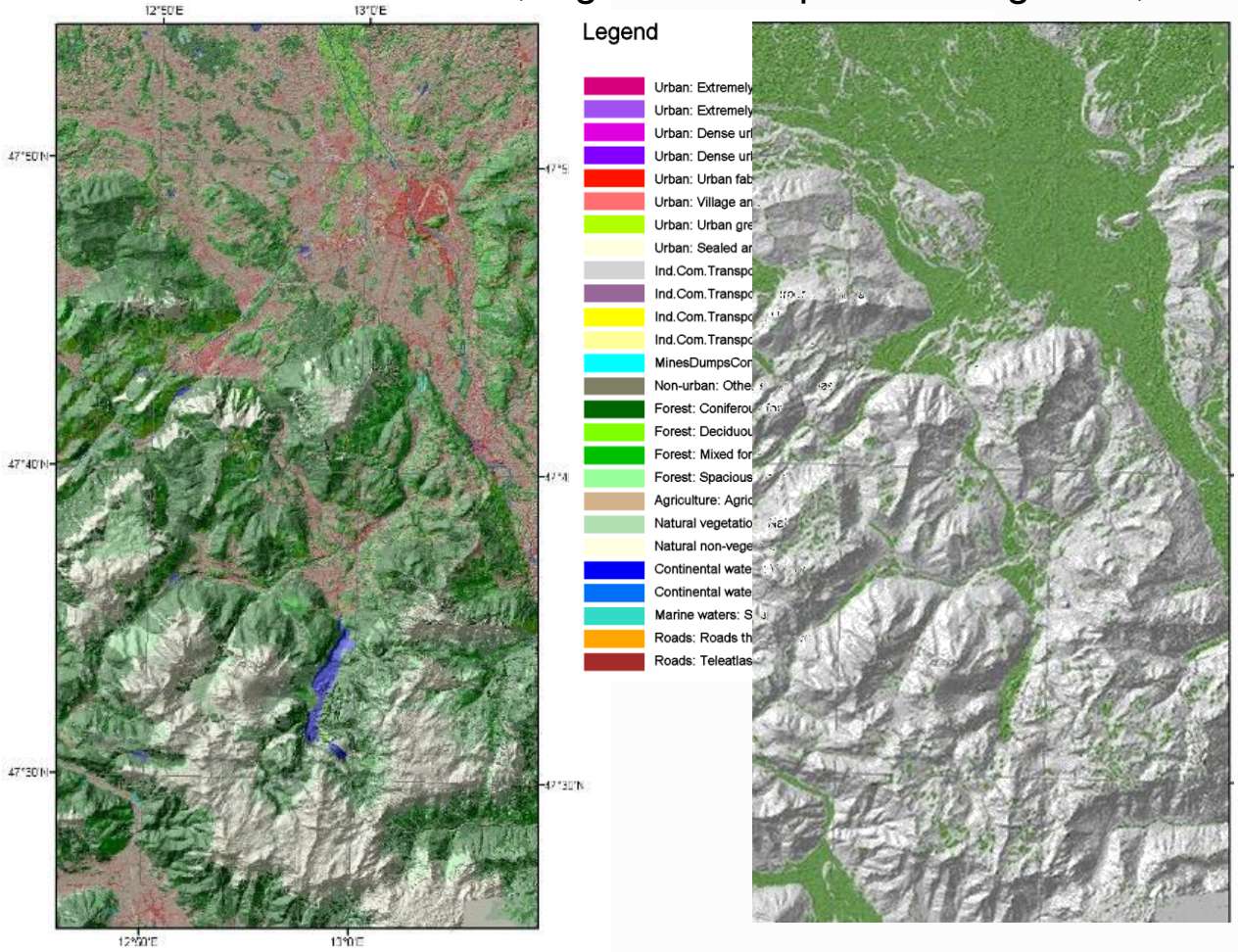
Sea Level: 0 m
Sea Level: + 3 m
Sea Level: + 5 m
Sea Level: + 10 m

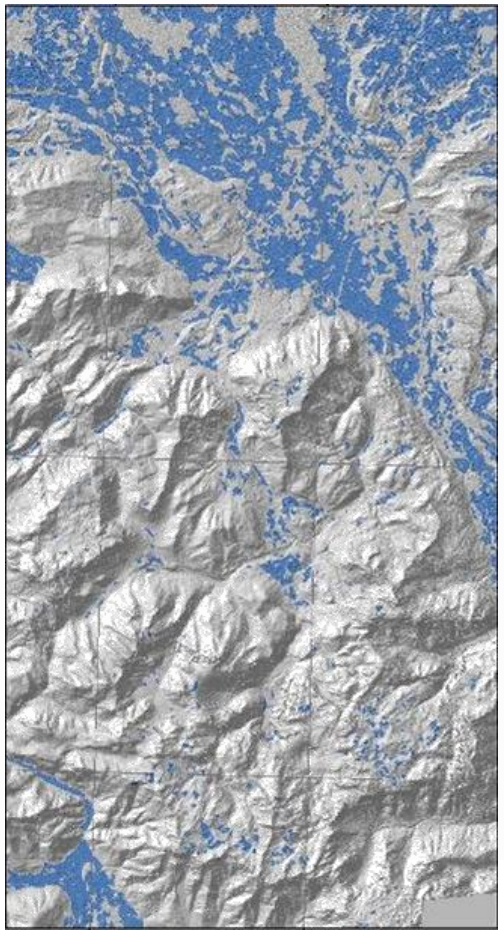
Test site: Toulon, France

Quality of Elevation Reference is decisive in Flood and Sea Level Rise modelling.

Case Study: Slope Analysis

Identification of flat areas, e.g. for Helicopter Landing Sites, …





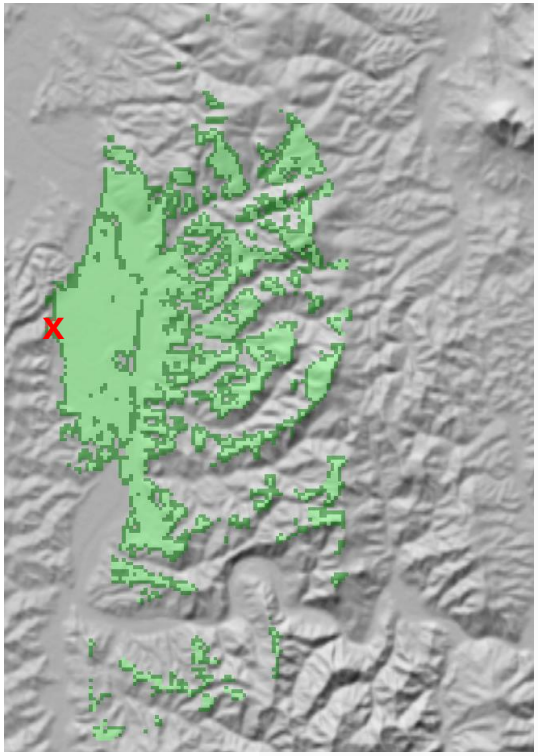
Landcover (Land25) **& Slope: < 5°** **:SRTM90** **:WorldDEM™**

Note: Displayed areas of >100m diameter

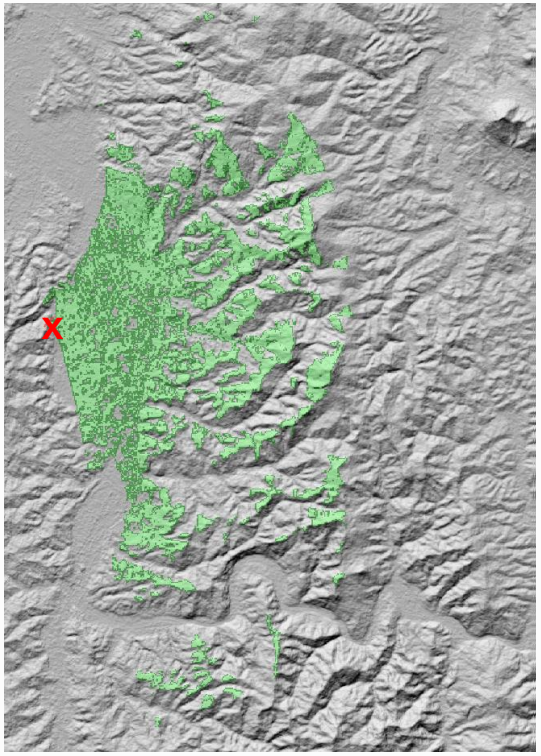
Case Study: Terrain Analysis (Line of Sight)

E.g. for terrestrial radio communication

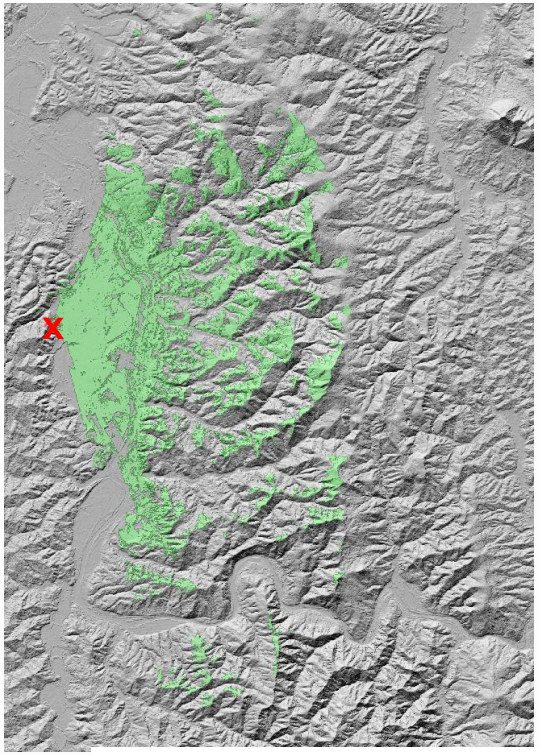
SRTM C-Band, 90m



ASTER GDEM, 30m



WorldDEM™, 12m



Test site: South-East of Teshio, Hokkaido (JPN)

4 WorldDEM™

Product Availability & Ordering

AIRBUS DEFENSE & SPACE

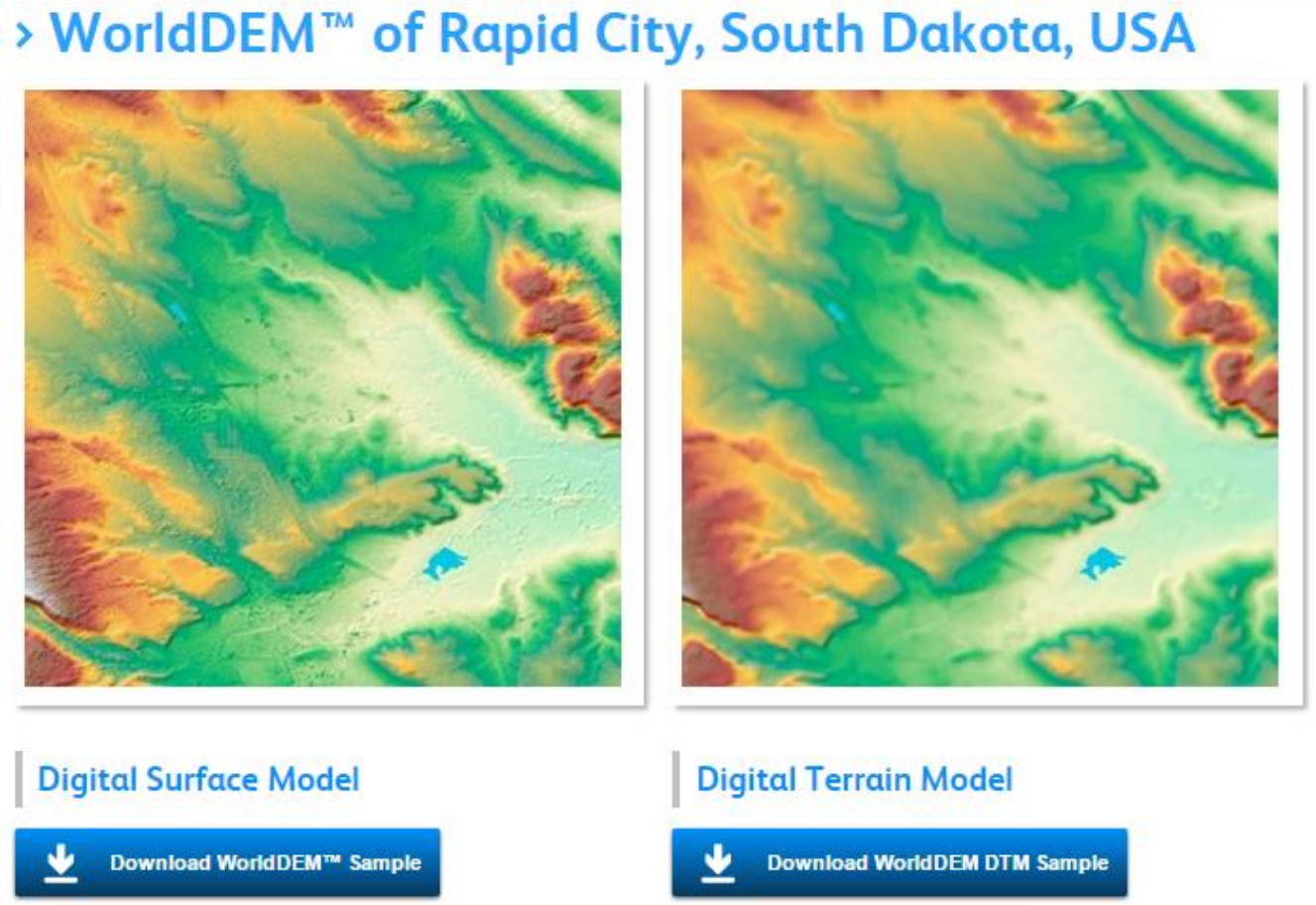
Database is growing

2014 2015

03 04 05 06 07 08 09 10 11 12 01 02 03 04

WorldDEM Sample Data

http://www.geo-airbusds.com/worlddem-sampledata/



Status: May 2015

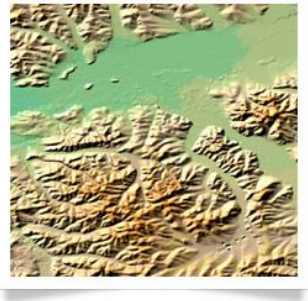
WorldDEM Sample Data

http://www.geo-airbusds.com/worlddem-sampledata/

Quintana, Uruguay

The WorldDEM shows a rural area between the two very small villages of Quintana and Fernández in the Salto and Tacuarembo Departments in the North-Western part of Uruguay.
The elevation range of the moderate terrain is between 160m to 425m.
The highlight of the topography is the river Rio Arapey Grande, which is one of the most important rivers of Uruguay. The main characteristic of the river areas are the forested river shore lines.

Download Quintana Sample DEM



Yakeshi, China

The WorldDEM of Yaskeshi is located in the autonomous region Inner Mongolia in the People's Republic of China
The elevation range within this hilly terrain ranges from 633m to 998m.

The diverse topography with urban and agriculture infrastructures and forested areas is characteristic for the city's economy, which is based on forestry industry, traditional Chinese medicines and farming.

Download Yakeshi Sample DEM

Sutherland, South Africa

The WorldDEM of Sutherland in the Northern Cape Province in South Africa shows a hilly to mountainous with elevation ranging from 366m to 1,842m.

The topography is characterised by the Roggeveld Mountain range which is part of the Large Karoo. Only a few small villages and towns are scattered around in the remote territory.

Sutherland's arid climate and remote location make its night skies among the world's clearest and darkest, the Southern African Large Telescope (SALT), the largest single optical telescope in the southern hemisphere, is installed here.

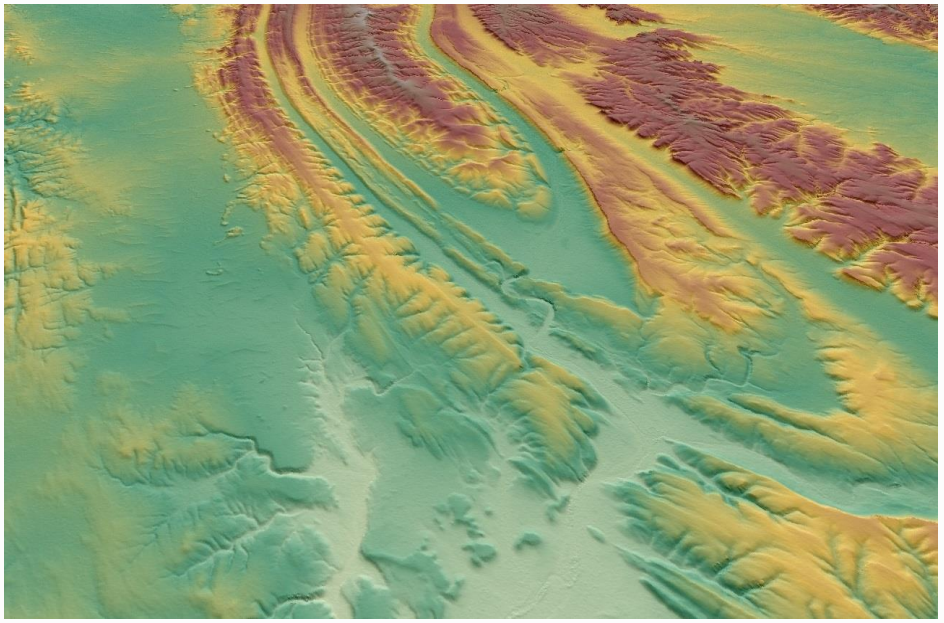
Download Sutherland Sample DEM

Status: May 2015

Contact Us

For more information and ordering, please contact Customer Service Team or your local Sales Manager

- E-mail: solutions@astrium-geo.com
- Phone: (703) 715-3100



http://www.geo-airbusds.com/worlddem/

AIRBUS DEFENSE & SPACE

AIRBUS
DEFENSE & SPACE